MEASURING AND REMOTE SENSING OF BURN SEVERITY

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ABSTRACT

The Composite Burn Index (CBI) is presented as a measure of burn severity that improves quantification and comparative study of fire effects. The CBI originates from field verification of remote sensing models on two burns that occurred during 1994 in Glacier National Park, MT, and constitutes a general strategy for burn site evaluation. From a matrix of criteria, attributes of the vegetative community are rated on a 7-point scale that defines severity of burning. Attribute scores then are hierarchically partitioned into strata, divisional, and overall composite ratings by averaging. Composite ratings convey unique parameters of burn effect, and yield ratio-level values readily applied in statistical analysis. Sampling confirms variable burn responses by strata over the range of severity values, and emphasizes the importance of considering a broad range of factors in summary ratings of severity. The variations, consistent with observed burn properties, suggest the matrix criteria and scale of measurement are relevant and appropriate. Total plot ratings are found to integrate all strata levels and provide the best measure of overall burn severity. Advantages of the CBI over previous methods include transportability, standardization, and inclusion of attributes that likely influence spectral reflectance. The CBI also facilitates direct correlation with quantitative environmental variables, and evaluation of between-burn differences.

We used the CBI ratings, above, to test performance of Landsat Thematic Mapper (TM) radiometric measures in distinguishing burn severity levels by remote sensing. In addition to post-fire TM data, multi-temporal image differencing of scenes acquired before and after fire was evaluated. Seasonal effects were also tested for a total of 8 models. We developed a new index, the Normalized Difference Burn Ratio (NDBR), and found it to be statistically superior to other measures when differenced from early growing-season dates. Identification of burned areas and distribution of severity levels was readily discernible on image products. Burn severity was then quantified and mapped by NDBR differencing on the two 1994 Glacier National Park fires. Modeled burn areas closely matched segments of fire perimeters digitized by GPS, and conformed spatially to burn traits documented in the field. The two fires differed in size, distribution, and magnitude of severity. Results demonstrated how this approach could become a routine method to compare fires across regions, and standardize portrayal of burn effects, especially on large remote fires. Advantages of NDBR differencing over other remote sensing approaches include high correlation to field-assessed burn effects, enhanced contrast of severity levels, reliable delineation of burn perimeters, and flexibility to apply the measure as a continuous or categorical variable in modeling and management.